

Citation for published version:

Mcclymont, D, Kolaczowski, ST & Molloy, KC 2010, 'Catalyst system design for the control of NO_x using hydrogen', DTC Summer Showcase 2010, Bath, UK United Kingdom, 8/07/10 - 9/07/10.

Publication date:
2010

Document Version
Peer reviewed version

[Link to publication](#)

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Catalyst System Design for the Control of NO_x Using Hydrogen

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1. What is NO_x?

- Nitric Oxides - highly reactive gases; primarily NO (>90 %) and NO₂
- Pollutants, involved in many atmospheric processes e.g. formation of smog
- Produced as a result of the high temperatures during combustion of fossil fuels
- Legislation is in place to reduce NO_x emissions

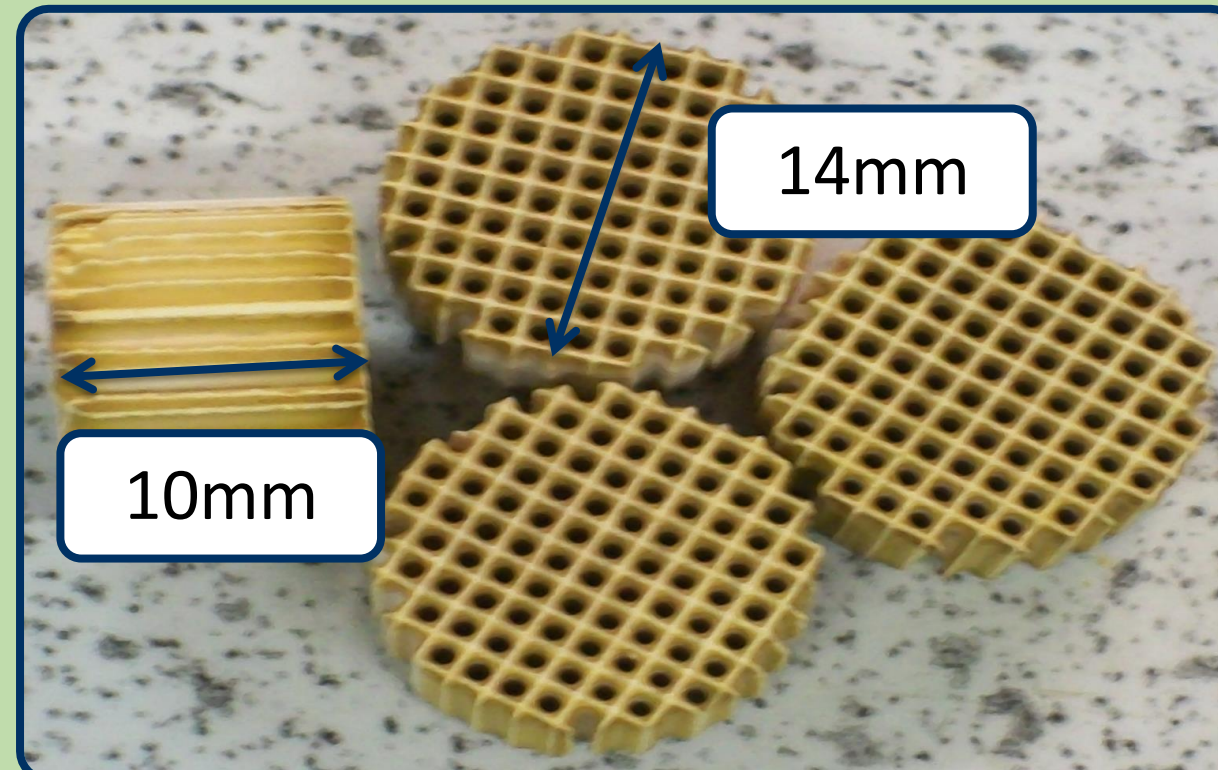


Figure 1 – Pd/Al₂O₃ monoliths

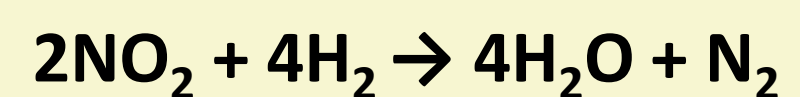
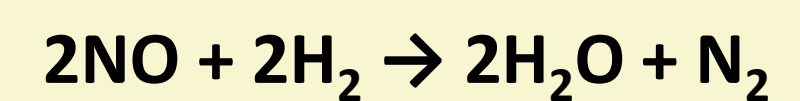


Figure 2 – 1 wt% Pd/Al₂O₃ pellets

3. H₂-SCR

- H₂ is already present in many systems e.g. diesel engines, biomass gasification combined heat and power (CHP) plants
- Could replace NH₃/urea processes:

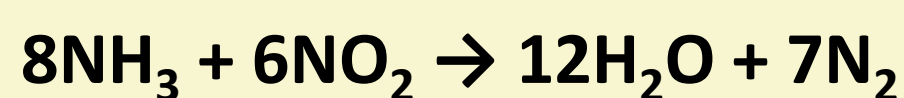
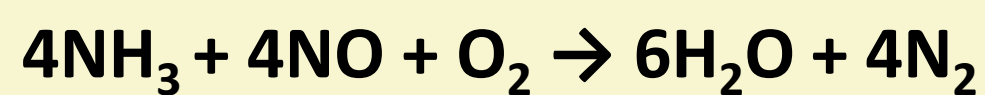
Target Chemistry



- Removes the need for additional chemicals and their associated costs

2. Current De-NO_x Processes

- NH₃/urea-Selective Catalytic Reduction (SCR) is an efficient, established method



BUT it requires additional toxic chemicals:

- Intrinsic safety issues
- Extra system costs
- NH₃/urea infrastructure necessary

4. Catalyst

- Pd/Al₂O₃ catalyst prepared using an incipient wetness impregnation technique
- Supported on honeycomb monoliths (Figure 1)
 - Outer diameter = 14 mm
 - Channel size = 1 mm x 1 mm (x 80)
- Compared to commercially available 1 wt% Pd/Al₂O₃ pellets (Figure 2)
 - Diameter = 3 mm

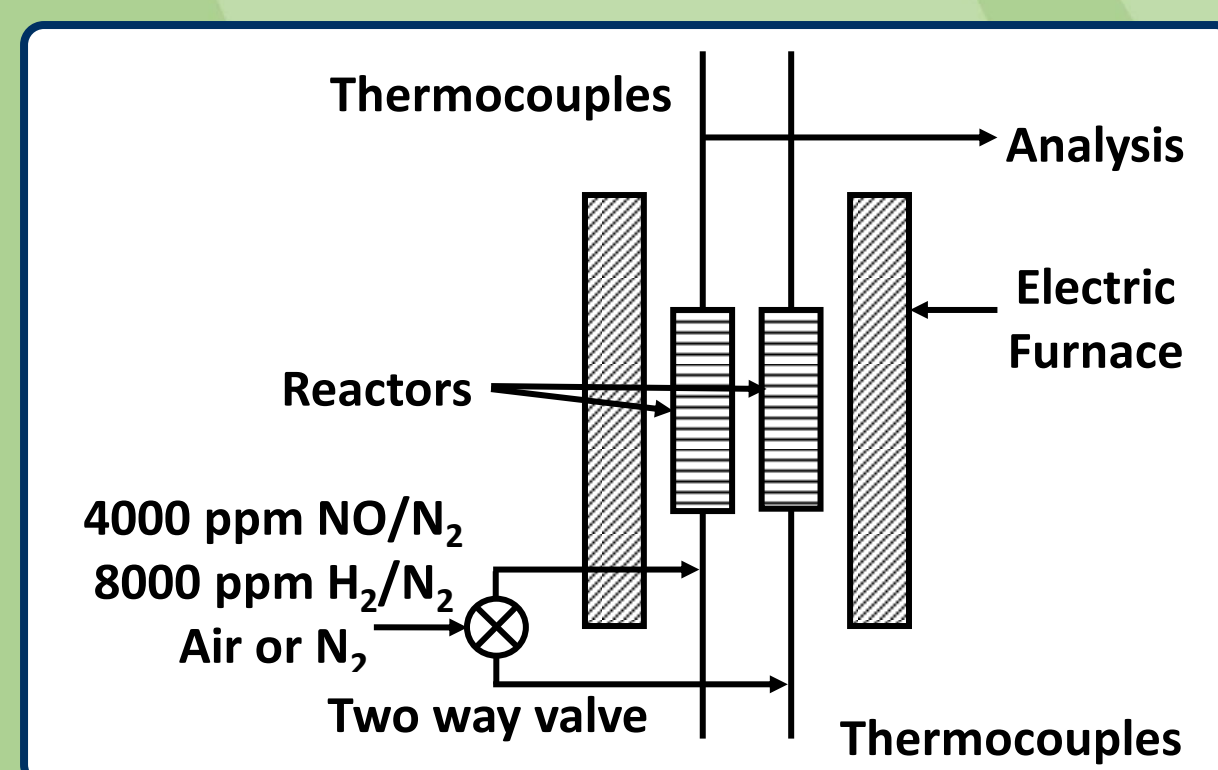


Figure 3 – Experimental set-up

5. Experimental Conditions

- Gas composition supplied to catalysts:
 - 1000 ppm NO
 - 1000 ppm H₂
 - Air (12.5 % O₂) or N₂
- Temperature varied from 50-250 °C (Figure 3)

7. Conclusions

- In the absence of O₂, Pd/Al₂O₃ catalysts can effectively reduce NO_x using H₂
- However, Pd/Al₂O₃ strongly promotes the reaction between H₂ and O₂, even at low temperatures
- Conditioning of the catalyst may be necessary to achieve maximum activity
- Some selectivity of products was seen at varying temperatures

6. Experimental Results

